Dec. 20, 1966 N. A. MacLEOD 3,292,613

MEANS AND METHOD FOR CONTROLLED PULSATORY FLOW OF BLOOD TO IMPROVE CIRCULATION

Filed June 21, 1963 2 Sheets-Sheet 1

Fig. 1.

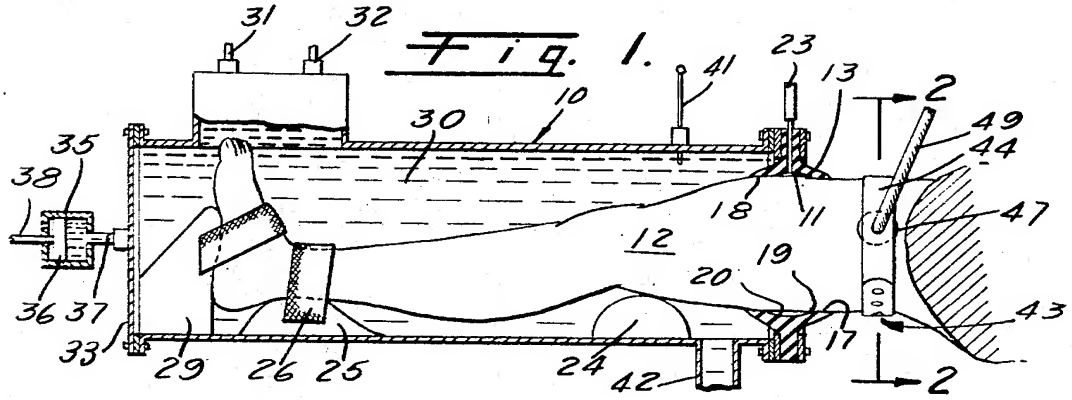

Fig. 2.

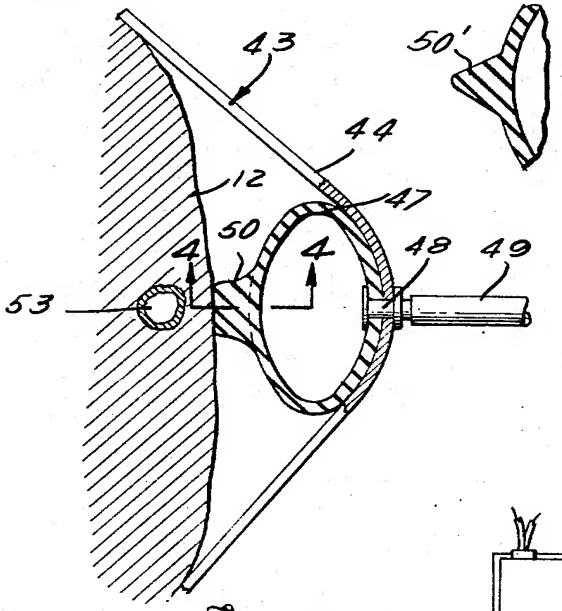

Fig. 4.

Fig. 3.

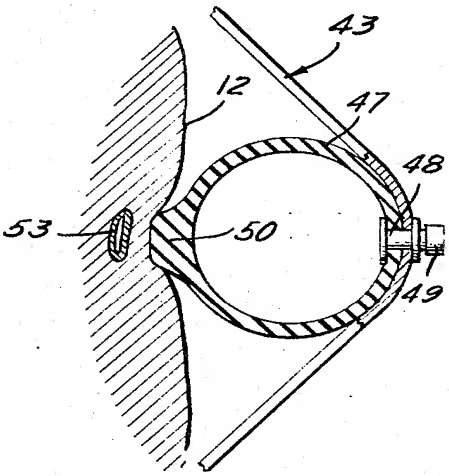

Fig. 5.

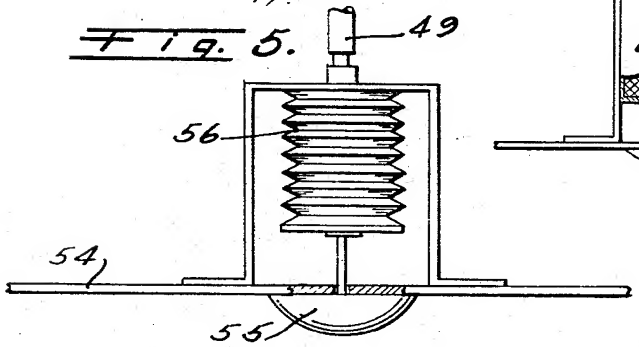

Fig. 6.

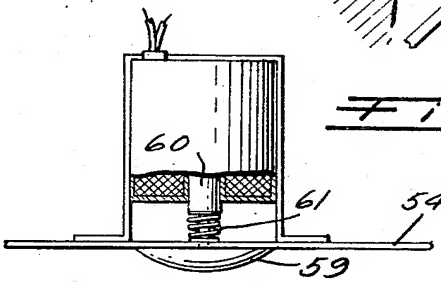

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Fig. 7.

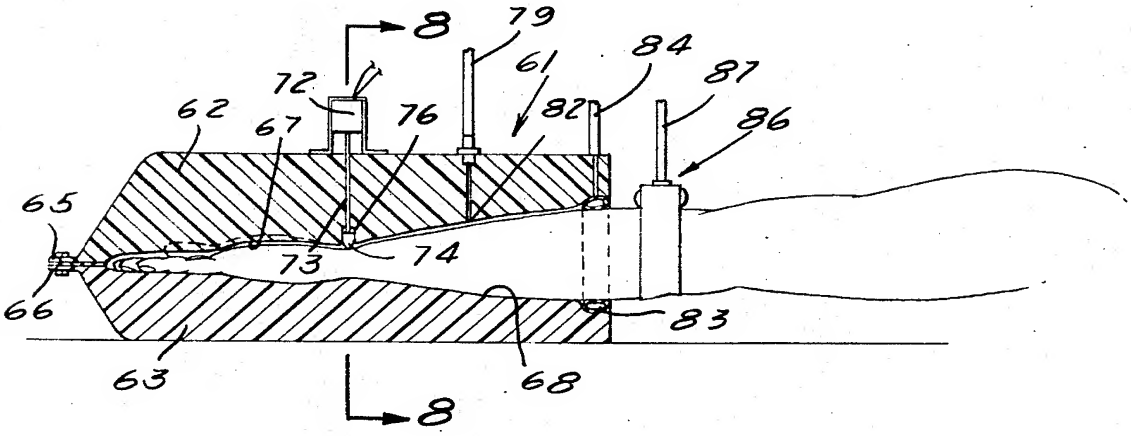
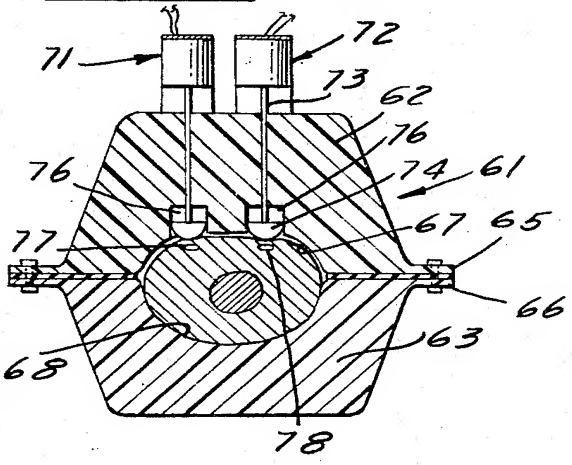


Fig. 8



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3,292,613

MEANS AND METHOD FOR CONTROLLED PULSATORY FLOW OF BLOOD TO IMPROVE CIRCULATION

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Filed June 21, 1963, Ser. No. 289,653
16 Claims. (Cl. 128—40)

This is a copending application of one which issued as United States Patent No. 3,094,983 for Blood Circulation Device and Method on June 25, 1963.

This invention relates to a method and apparatus for improving the circulation of fluids within parts of a human body or an animal and, more particularly, is for the purpose of improving blood circulation in a human body or in that of an animal.

When blood is pulsed from the heart into the arteries, the blood discharge valves of the heart close, and the pressure impulse in the blood is absorbed by the arterial flow and by the distention of the elastic walls of the arteries. The distention of the arteries tends to maintain a more uniform blood flow to the arterioles and from them to the capillary bed. The return flow from the capillaries through the veins to the heart is a much more steady one than in the arteries and it is subject to control against back flow by a series of check valves in the veins.

As described in my above patent, it is clear that variations of pressure applied to a limb or any other part of the body act differently on the venous flow than on the arterial flow. In the veins, a negative pressure application to a limb which would tend to draw blood away from the heart cannot do so because of the check valves in the veins, and a positive pressure application tends to squeeze the veins, open the venous valves, and force the blood to the heart. However, in the arteries, applications of negative and positive pressures tend to cause surging of the blood toward and away from the heart.

According to the invention, I have found that much greater stimulation of blood circulation is possible when the arterial surge toward the heart, on application of a positive pressure, is reduced or stopped entirely. That is, when there is a localized pressure applied at the well-known arterial pressure points, at which pressure can be applied from the skin surface, the arterial flow is greatly reduced or even entirely stopped downstream of the localized pressure points in the direction away from the heart. Actually, at any point where arterial pulsing can be felt, pressure can be applied to occlude an artery.

My method for greatly increasing the stimulation of blood circulation includes the enclosing in a chamber of a part of a body, such as a leg, and applying a positive pressure pulse within the chamber and at the same time applying a localized pressure at the appropriate arterial pressure point, this latter pressure being maintained during the period of the positive pressure pulse within the chamber and preferably for a relatively short period therebefore and thereafter. The foregoing steps prevent the flow of blood toward the heart in the artery in question and force the flow away from the part in the chamber into the capillaries and veins and back to the heart.

When a larger portion of the body, for example, that part from the waist down, is sealed within a variable pressure chamber, the localized pressure means on individual arteries are enclosed within the chamber and are operable from the exterior thereof.

According to the invention, consistent with the foregoing, when a negative pressure pulse is applied to a part of a body within a variable pressure chamber to tend to pull arterial blood from the heart, the checking action of the valves in the veins can be assisted by applying localized pressures on the major veins which are found near the surface of the body. By this method, blood flow in the enclosed body portion can be made greater than that under conditions of violent exercise, but without any strain upon the heart.

In the practice of this method, it is not necessary to synchronize pressure variation with the heart action, but when such synchronization is desired, the occlusion of the artery should preferably occur when the heart is not pumping to the artery, that is, when the arterial pressure is the lowest, and the occluding pressure should be relaxed when the arterial pulse is at its peak pressure so that the blood can flow into the encased body part.

Localized pressure points, where arterial occlusion by indentation of the skin can be produced, are, for example, on the femoral artery which supplies most of the blood to the leg, on the popliteal artery at the back of the knee, on the posterior tibial artery at the ankle, and on the brachial artery in the arm. The brachial vein is adjacent to the latter artery and some venous occlusion results from brachial artery occlusion, but the deep-seated axillary vein in the upper arm cannot be occluded. A similar situation obtains in the leg in regard to hte juxtaposition of the femoral artery and femoral vein and venous flow through other deep-seated veins. At the wrist, both the radial and ulnar arteries can be readily occluded. In certain serious failure of leg or arm circulation, superficial surgery can be performed to make the femoral artery of the leg and the branchial artery of the arm more available for occlusion pressures.

As pressures of 2 to 10 pounds per square inch, or 150 to 500 millimeters of mercury, can be safely applied, a very positive blood circulation can be induced. In terms of regeneration of limb functions, this is most important and has considerable therapeutic value in such diseases as arthritis, traumatic injuries, and all forms of peripheral vascular disease.

The use of liquid in a variable pressure chamber to apply pressure pulses on a part of a body is preferable to gas because of the non-compressibility of the liquid, but it is more difficult to handle. However, it has been found that when the chambers are so shaped to closely conform with the part of the body inserted therein so as to eliminate excess volume in which a gas can be compressed or expanded by pressure variation within the chamber, a gas can be used effectively as the medium for applying the pressure pulses when the arterial occlusion method is used. That is, in the use of a gas, for practical purposes, air, the volume in the chamber around the body portion therein must be reduced as much as possible and this can be done with non-porous pads. Even so, however, in the use of a gas, as compared with a liquid, the pressure-time curve cannot be as steep and the negative and positive pressures cannot be cycled as quickly.

Accordingly, it is an object of the present invention to provide an improved method and an improved apparatus for increasing blood circulation.

It is another object of the present invention to provide a method and means to provide positive pressure pulses to a part of a human body or an animal while an artery or arteries to the part are occluded.

It is still another object of the present invention to provide means and a method for applying negative pressures to a part of a body while a major vein or veins are occluded to assist the check valves in the veins. In elderly persons and in certain diseases, the check valves in the veins are inefficient and, therefore, the occlusion of the veins during negative pressure impulses inhibits back flow into the veins and greatly increases positive blood

flow into the body part. This is especially effective when the occlusion of the vein is associated with the use of arterial occluding means during the period of rising pressure from a minimum negative to a positive pressure, the latter arterial occluding means being applied during the entire period of positive pressure.

It is a further object of the present invention to provide an improved method and apparatus for increasing blood circulation in a limb, for example, and which will eliminate distention of the arteries of the limb outside of the chamber and between the chamber sealing means and the heart during positive pressure pulses within the chamber. This elimination of distention of the arteries outside the chamber results from the occlusion of the artery or arteries in question during the positive pressure pulse.

It is a still further object of the present invention to provide an improved method and apparatus by which a very considerable positive pressure gradient can be created from an artery in an enclosed limb, and through the capillaries to the veins.

It is another object of the invention to provide an improved method and means for applying a localized pressure on near-surface arteries to inhibit arterial flow and at the same time apply a positive pressure pulse to that portion of the body downstream of the point of the localized pressure so that the positive pressure pulse is more usefully employed in forcing blood from the arteries and arterioles into the capillaries and from the capillaries into the veins than has heretofore been experienced.

Further objects and advantages of the invention may be brought out in the following part of the specification wherein small details have been described for the competence of disclosure, without intending to limit the scope of the invention which is set forth in the appended claims.

Referring to the accompanying drawings, which are for illustrative purposes only:

FIG. 1 is a side elevational view, partially in cross section, of an apparatus according to the present invention;

FIG. 2 is a cross sectional view of an artery occluding device, taken as indicated by the line 2—2 in FIG. 1;

FIG. 3 illustrates the occluding device in FIG. 2 in operation;

FIG. 4 is a fragmentary, cross sectional view of an occluding device having a relatively pointed contacting part;

FIG. 5 is a fragmentary, cross sectional view of another embodiment of an occluding device;

FIG. 6 is a fragmentary, cross sectional view of a solenoid-operated occluding means;

FIG. 7 is a side elevational view, partially in cross section, of another embodiment of the invention; and

FIG. 8 is a cross sectional view, taken as indicated by the line 8—8 in FIG. 7.

Referring again to the drawings, in FIG. 1, there is shown an elongated chamber **10**, having an open end **11** and having a cross section suitable to receive a substantial portion of a human leg **12**. At the open end there is a seal **13**, having its outer periphery adapted to be secured to a flange on the chamber and having its inner periphery **17** substantially annular to conform to the periphery of the leg **12**. The inner periphery of the seal has two lips **18** and **19**, spaced by an enlarged diameter surface **20**. The seal is maintained by a negative pressure made available through a tube **23**, terminating inwardly through the surface **20** so that the negative pressure draws the skin of the leg against the surfaces of the lips **18** and **19** and toward the surface **20**, a greater pressure at all times being exerted on the exterior surfaces of the seal to force it into sealing relationship with the leg.

The leg is shown to be resting within the chamber **10** on hard rubber cushions or blocks **24** and **25** and it is

secured to the latter block by a strap **26**. The foot is also strapped to a block **29**, in turn secured to the chamber, so as to tend to hold the foot in the position shown. The straps may be secured to the foot and ankle through a removable access flange **33**.

The chamber **10** is adapted to be completely filled with a liquid **30**, such as water, as disclosed in the above-mentioned copending application. It may be filled through a fitting **31** and vented, while filling, through a fitting **32** to which a pressure gauge may be attached after the chamber is completely filled.

At the left end of the chamber in the drawing, there is a cylinder **35** having a reciprocating piston **36** therein. One end of the cylinder is connected to the chamber by a tube **37** so that movement of the piston **36** will change the pressure within the filled chamber. Through the other end of the cylinder extends a piston rod **38**, connected to the piston **36**, and which may be reciprocated to move the piston by conventional means. The piston can be adjusted to have a starting position, either with a zero gauge pressure or a constant positive or negative pressure, and any movement of the piston will then increase or decrease the pressure in the chamber. Adjacent the other end of the chamber is a thermometer **41** fitted within the chamber to indicate the temperature of the liquid. In the lower portion of the drawing is a sealable drain **42**.

In FIGS. 1–3, there is shown an artery occluding device, generally designated as **43**, secured to the leg by a strap **44**. A generally spheroidal-shaped ball **47** is fitted between the strap and the leg, being secured to the strap by a flanged tube **48** having an opening into the ball and having its outer end connected to a gas or liquid pressure tube source **49**. The ball is made of plastic flexible material so as to be inflatable, and has a relatively hard projection **50** in abutment with the leg surface, immediately outwardly, in this case, of the femoral artery **53**.

In FIG. 2, the ball **47** is shown deflated or substantially compressed by the strap **44** around the leg and the artery **53** is shown to be open. In FIG. 3, the ball **47** has been inflated with pressure through the source **49** so as to exert considerable pressure on the leg so as to close or substantially close the artery **53**.

In FIG. 4, there is shown a ball equivalent to ball **47**, having a more pointed projection **50'** which, for example, is adaptable for use on the radial and ulnar arteries in the wrist. In FIG. 5, there is shown an artery or vein occluding device secured to a strap **54**, equivalent to strap **44**. Here, the projection **55** for occluding the artery or vein is connected by a rod to a pressure extensible bellows **56** which in turn is connected to a pressure source **49**. When the pressure is increased within the bellows from the source **49**, the projection **55**, as indicated in FIG. 3, moves against the skin so as to occlude the blood-carrying member.

In FIG. 6, there is shown another embodiment of an occluding device secured to a strap **54'** and having a projecting member **59**, connected to a solenoid core **60** by a rod surrounded by a coil spring **61**. The spring acts to hold the projecting member in its retracted position and when the solenoid is energized, the core is moved against the spring so as to move the projecting member **59** into its extended position against the skin so as to occlude the blood carrying member.

The device shown in FIG. 1 can be operated in a number of different ways and with many variations in pressure. For example, a positive pressure can be exerted on the leg **12** by means of moving the piston **36** inwardly toward the chamber and just before the positive pressure is applied, the ball **47** can be energized by pressure from the source **49** so as to be expanded, as shown in FIG. 3, to occlude the artery **53**. By occluding the femoral artery and applying pressure to the leg, the blood is forced through the artery downstream of the occluding device **43** and is further forced through the capillaries and the veins in a manner to greatly exceed the normal flow, especially where

the circulation is poor. The indenting pressure on the artery should ordinarily be maintained during the entire positive pressure application to the chamber. Then, when a negative pressure is applied by moving the piston **36** away from the chamber, the pressure on the artery is released, as indicated in FIG. 2, and the blood is caused to flow into the artery at a much greater rate than under normal conditions.

The pressure can be synchronized to the heart beat or can be applied less or more frequently and in regular multiples of a heart beat, for example, during every second or third heart beat, or two, three, or four times during each heart beat, or the pressure can be applied irregularly with respect to the heart beat. Further, where synchronization with the heart is desired, the occlusion of the artery should preferably occur when the heart is not pumping to it, that is, when the arterial pressure is the lowest, and the occluding pressure should be relaxed when the arterial pulse is at a peak pressure so that the blood can readily flow into the encased limb.

When a positive pressure is applied to the chamber, the limb or leg, as shown, tends to move out of the chamber, and thus, the straps are applied to the ankle and foot to prevent the latter from moving and to restrict the outward movement of the leg.

Where the check valves in the veins are inefficient, a major vein can be occluded during the negative pressure application in the chamber so that the negative pressure will not tend to draw blood through the veins in the wrong direction, and this will permit the negative pressure to act upon the arterial flow from the heart so that it will be at a maximum into the limb.

As previously indicated, a liquid is the preferable medium for applying rapid pressure changes to a part of a body, but it has the disadvantage that it has to be handled. A gas, such as air, of course, does not have such a disadvantage but because it is compressible, it is not as good a medium as liquid to apply rapid pressure changes to a limb. However, when a gas in a chamber is restricted to a very small volume surrounding a limb and a relatively large piston displacement is involved for producing pressure variation, there is not much difficulty in compression or expansion of the gas and the pressure can be adequately applied to a limb with air.

An apparatus, as shown in FIGS. 7 and 8, for use of air as the pressure-applying medium is particularly useful in stimulating blood flow in the hand. An air chamber **61** is formed between upper and lower molded plastic parts **62** and **63**, sealingly secured together at their flanges **65** and **66**. The upper part **62** has an inner molded surface **67** to conform to the inner parts of a hand and forearm and the lower part **63** has an inner surface **68** to conform to the outer parts of the hand and forearm. The arrangement shown permits only a minimum of air in the chamber between the arm and hand surfaces and the surfaces of the chamber. If, for example, there would be excess space between the hand and the chamber, nonporous plastic material could be inserted on the arm and hand to reduce the air volume.

In this embodiment, solenoid-operated occluding devices, similar to the type shown in FIG. 6, are used at the wrist to occlude the radial and ulnar arteries. Here, as distinct from the structure shown in FIG. 1, the artery occluding means is within the chamber, rather than externally thereof. However, in either type of chamber, the artery occluding means may be externally or internally of the chamber.

The artery occluding devices **71** and **72** have rods **73** connecting the solenoid cores with the projecting plungers **74** which are slidably engaged in recesses **76** in the upper part of the chamber **62**. As shown in FIG. 8, the projecting plungers **74** are shown in their non-extended positions having a tight fit on the wrist so that when the solenoids are energized, the two plungers **74** move downwardly to occlude the wrist arteries **77** and **78**.

In FIG. 7, a chamber pressure source **79** extends from a variable pressure means, such as a negative and positive pressure varying air pump, not shown, but equivalent in effect to the cylinder and piston **35** and **36**, respectively, in FIG. 1, and terminates at its inner end **82** in the chamber formed by the surfaces **67** and **68**, adjacent the arm.

At the opening of the chamber, there is a generally annular pressure seal **83**, adapted to be tightened within the chamber opening and on the arm by a liquid or fluid pressure supplied through a tube **84**.

Externally of the chamber on the arm is a vein occluding device **86**, equivalent to the artery occluding device **43**, shown in FIGS. 1, 2 and 3, the device **86** being strapped to the arm and being actuated by a fluid pressure through a tube **87**.

The operation of the chamber, shown in FIGS. 7 and 8, is substantially the same as that shown in FIG. 1. However, with air as the medium to apply the pressure variations to the limb, the pressure-time curve cannot be as sharp and the cycling of the pressure variation cannot be as fast as with liquid.

Since circulation problems are more severe in the arm below the wrist than above the wrist, and because of the convenient location of the radial and ulnar arteries, it is considered advantageous to occlude them at the wrist, as shown in FIGS. 7 and 8. Thus, when the high pressure is applied from the source **79** to the chamber and arm and just prior thereto, the solenoids in the devices **71** and **72** are energized to occlude the arteries. The pressure will then force the blood into the hand so that it can return to the heart through the veins. According to the cycle, when the negative pressure is applied from the source **79**, the solenoids in the devices **71** and **72** are deenergized and the rods **73** are retracted by means of springs, not shown, so that the arteries at the wrist are opened. At this time, the blood is free to flow into the arm and hand from the arteries, and in cases where the vein check valves need assistance, the vein occluding device **86** is actuated by the application of pressure through the tube **87**. This prevents blood from being drawn into the arm and hand through an improperly operating check valve in the vein and the flow is thus, then into the arm and hand from the arteries in a greater than normal amount due to the negative pressure on the limb, and there is no blood drawn into the arm and hand, in the wrong direction, through the vein.

It should be noted that in certain serious failures of leg or arm circulation, such as occurs during gangrene, surgery can be performed to make the femoral artery of the leg or the brachial artery of the arm available for the application of occlusion pressures in accordance with the invention.

The invention and its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the arrangement hereinbefore described being merely by way of example. I do not wish to be restricted to the specific form shown or uses mentioned, except as defined in the accompanying claims, wherein various portions have been separated for clarity of reading and not for emphasis.

I claim:

1. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:

(a) applying a pressure pulse to a part of a body to affect the flow in an artery in said part; and

(b) applying localized pressure to said artery between a portion of said part and the heart to inhibit reverse arterial flow toward the heart during said pressure pulse.

2. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) applying a pressure pulse to a part of a body to affect the downstream blood flow in said part; and
(b) applying localized pressure to a near-surface artery to said part between a portion of said part and the heart to inhibit reverse arterial flow toward the heart during said pressure pulse.

3. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) applying negative pressure pulses ambient and to a part of a body to tend to pull arterial blood from the heart and through said part; and
(b) applying localized pressure adjacent said part on a near-surface vein during said pulses to assist the action of the vein check valves.

4. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) enclosing a part of a body to be treated in a chamber;
(b) sealing said part in said chamber;
(c) filling said sealed chamber with liquid;
(d) varying the pressure of all of said liquid alternately positively and negatively a predetermined amount at a predetermined rate; and
(e) applying pressure to an artery to said part upstream of a portion of said part to be affected by said varied pressures to inhibit arterial flow from said portion toward the heart during the periods the varied pressures applied are positive.

5. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) enclosing a part of a body to be treated in a chamber;
(b) sealing said part in said chamber;
(c) filling said sealed chamber with liquid;
(d) applying negative pressure pulses to all of said liquid to tend to pull arterial blood from the heart; and
(e) applying localized pressure on a near-surface vein downstream of a portion of said part to be affected by said negative pulses during the period said pulses are applied to assist the action of the vein check valves.

6. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) enclosing a part of a body to be treated in a chamber;
(b) sealing said part in said chamber without substantially affecting the circulation in said part;
(c) filling said sealed chamber with liquid;
(d) applying alternate negative and positive pressure pulses to all of said liquid;
(e) applying localized pressure during said positive pulses on said body adjacent said part to an artery extending in said part to inhibit arterial flow from said part toward the heart; and
(f) applying localized pressure to a vein adjacent said part during said negative pulses.

7. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) applying alternate negative and positive pressure pulses ambient and to a part of a body;
(b) applying localized pressure to a vein adjacent said part during said negative pulses; and
(c) applying localized pressure on said body adjacent said part to an artery extending into said part to inhibit arterial flow from said part toward the heart during said positive pulses.

8. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) enclosing a part of a body to be treated in a chamber;
(b) said chamber conforming to the shape of said part therein and the interior surfaces of said chamber being in juxtaposition with corresponding surfaces of said part;
(c) sealing said part in said chamber without substantially affecting the circulation in said part;
(d) filling said chamber with a gas;
(e) applying positive pressure pulses to said gas within said chamber; and
(f) applying localized pressure on said body to an artery extending in said part to inhibit arterial flow from said part toward the heart during said positive pulses.

9. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:
(a) enclosing a part of a body to be treated in a chamber;
(b) said chamber conforming to the shape of said part therein and the interior surfaces of said chamber being in juxtaposition with corresponding surfaces of said part;
(c) sealing said part in said chamber without substantially affecting the circulation in said part;
(d) filling said chamber with a gas;
(e) applying alternate negative and positive pressure pulses to said part by applying said pulses to said gas;
(f) applying localized pressure during said positive pulses on said body to an artery extending in said part to inhibit arterial flow from said part toward the heart; and
(g) applying localized pressure to a vein extending in said part during said negative pulses.

10. The combination of a variable liquid pressure device for affecting circulation in a part of the body of a human being or an animal, and means for controlling pulsating flow of blood in said part, comprising:
(a) a chamber for containing a liquid under pressure,
(b) said chamber having an opening adapted to receive a part of a body;
(c) a seal being formable at said opening in contact with said body to close said chamber, said seal applying a pressure low enough to said part so as to not substantially affect the circulation in said part;
(d) means to fill said chamber with liquid after said opening is closed;
(e) means to apply positive pressure pulses to all of said liquid; and
(f) means adapted to provide a localized pressure on an artery extending in said part to occlude arterial flow from said part toward the heart during the period of said pulses.

11. The combination of a variable liquid pressure device for affecting circulation in a part of the body of a human being or an animal, and means for controlling pulsating flow of blood in said part, comprising:
(a) a chamber for containing a liquid under pressure,
(b) said chamber having an opening adapted to receive a part of a body;
(c) a seal being formable at said opening in contact with said body to close said chamber, said seal applying a pressure low enough to said part so as to not substantially affect the circulation in said part;
(d) means to fill said chamber with liquid after said opening is closed;
(e) means to apply alternate positive and negative pressure pulses to all of said liquid;
(f) means adapted to provide a localized pressure on an artery extending in said part to inhibit arterial

flow from said part toward the heart during the period of said positive pulses; and

(g) means adapted to provide a localized pressure to a vein extending in said part during the period of said negative pulses to assist the action of the vein check valves.

12. The combination of a variable gas pressure device for affecting circulation in a part of the body of a human being or an animal, and means for controlling pulsatory flow of blood in said part, comprising:

(a) a chamber for containing a gas under pressure and having an opening to receive a part of a body,

(b) said chamber being adapted to conform to the shape of said part and the interior surfaces of said chamber being adapted to be in juxtaposition with corresponding surfaces of said part;

(c) a seal being formable at said opening in contact with said body to close said chamber, said seal applying a pressure low enough to said part so as to not substantially affect the circulation in said part;

(d) means to fill said chamber with gas after said opening is closed;

(e) means to apply positive pressure pulses to said gas in said chamber; and

(f) means adapted to provide a localized pressure on an artery extending in said part to inhibit arterial flow from said part toward the heart during the period of said positive pulses.

13. The invention according to claim 12 including:

(a) means to apply negative pressure pulses to said gas alternately with said positive pressure pulses; and

(b) means adapted to provide a localized pressure to a vein extending in said part during the period of said negative pulses to assist the action of the vein check valves.

14. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:

(a) applying a positive pressure pulse to a part of a body to improve the normal direction flow in an artery, the capillaries, and the veins in said part; and

(b) occluding said artery to said part at a point upstream of a portion of said part to close the artery and to prevent reverse flow toward the heart in said artery during said pressure pulse, and without restricting the normal direction flow toward the heart of the blood in the part downstream of said point.

15. A method of improving the blood circulation in a part of the body of a human being or an animal, comprising:

(a) enclosing a part of a body to be treated in a chamber;

(b) sealing said part in said chamber;

(c) filling said sealed chamber with liquid;

(d) varying the pressure of all of said liquid alternately positively and negatively a predetermined amount at a predetermined rate; and

(e) occluding an artery to said part at a point upstream of a portion of said part to be affected by said varied pressures to close said artery and to prevent reverse flow toward the heart in said artery during the periods the varied pressures applied are positive, and without restricting the normal direction flow toward the heart of the blood in the part downstream of said point.

16. A method of improving the blood circulation in a part of a body of a human being or an animal, comprising:

(a) enclosing a part of a body to be treated in a chamber;

(b) said chamber conforming to the shape of said part therein and the interior surfaces of said chamber being in juxtaposition with corresponding surfaces of said part to provide a minimum of space between said surfaces;

(c) sealing said part in said chamber;

(d) filling said chamber with a gas;

(e) applying positive pressure pulses to said gas within said chamber; and

(f) occluding an artery to said part at a point upstream of a portion of said part to be affected by said pressure pulses to close said artery and to prevent reverse flow toward the heart in said artery during the periods of said positive pressure pulses and without restricting the normal direction flow toward the heart of the blood in the part downstream of said point.

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